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THE SLIME MOULDS.

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(Plate 16.)

IN view of the many points of curious and biologic interest attaching to the Slime Moulds, it is remarkable that they have not been more widely collected and studied in this country. They are ubiquitous; they grow in field and forest, in orchard and garden, about every farm, nor less in every hamlet, in town and in city, in our hot-houses in winter, in our flower-beds in summer. In fact, wherever anything else can grow, especially anything of the mould or fungus kind, there slime moulds, at one time or another, are sure to be found. True, the smallness of their fructifications removes them somewhat from ordinary discovery, but some of them are large enough, and nearly all of them make up in the number of their sporangia what may be lacking in size, so that, on the whole, slime moulds are certainly not less conspicuous than other small forms of fungal life.

Besides, they possess in most of their species, in both color and structure, a certain curious elegance that makes them very attractive to every one who has the slightest sense of artistic delicacy and beauty.

But far beyond all this lies the interest attaching to these forms as living things. In their life-history they are unlike anything with which we elsewhere have to do. They are like moulds in that they use as food organic materials; they are unlike moulds in that they are destitute of hyphæ, and in their vegetative phase present simply a mass of slime, apparently without organization, without form, without structure of any kind; and yet living, moving, intact, cellular, multinuclear, and in growth and development evincing all the complexity of mitotic cell-division. They live as naked protoplasm, protoplasm in its "mineral

condition," if one might so say, creeping about on this worn old planet with all the freshness of Creation's youth. It is of course needless to mention here the interest attaching to protoplasm. This is the form of matter which everywhere fascinates the student of biology; the secret of life is with it. For the last twenty-five years, in all sorts of physiologic and biologic treatises, the tiny amœba has been made to play the leading rôle; but the plasmodium, that is, the vegetative, active phase of a slime mould, is worth a thousand amœbas; it exhibits vital phenomena on such a macroscopic scale. Contractility, irritability, assimilation, automatism, and all the other wondrous properties, so called, of living matter are here to be seen in their most beautiful display.

In our university laboratory a few weeks since, we had the plasmodium of a Tilmadoche (*T. polycephala* Schw.). To a piece of *Agaricus sapidus* the size of one's hand a little of the clear yellowish plasmodium was transferred, and the whole covered by a large bell-glass. The plasmodium increased rapidly in size, perceptibly so within an hour. In twenty-four hours, all over the walls of the bell-jar there were sheets and streams of protoplasm spreading and massing like an invading army in all directions, while the agaric melted before it. Fresh pieces of agaric were from time to time supplied, and were as rapidly consumed, until the plasmodium had increased to such dimensions that it completely lined the glass and hung down in streaming pillars and columns from the summit. The plasmodium was divided, and every one who chose made a culture for himself; the streams were induced to run and spread on slides, transferred to microscopes and so watched, as the currents oscillated to and fro; some parts were gathered on cover-glasses, stained and mounted to show the swarming nuclei. All the wonderful phenomena seemed susceptible of indefinite continuance; but unhappily cold weather came upon us; our supplies of fresh agaric failed. We softened up dry material of similar sort, but our slime mould, delicate connoisseur that it was, refused to be fed on food of our selection further, and presently succumbed to the assaults of a horde of real moulds and fungi that found our new supplies of pabulum quite suited to their less discriminating taste. The eater in turn was eaten. In the case of several bell-jars, however, we allowed the plasmodium to continue undisturbed its favorite food-supply and made no attempt at all to set forth a new menu. In these cases the net-work streamed about a

while, lost color, and finally everywhere transformed itself into a thousand tiny, sculptured, capitate sporangia, raised each upon a slender fibrous stem, each sporangium packed with abounding spores, in form and color characteristic of the species. Only in one particular were the spores abnormal; not a few were far too large. It would seem that in some cases the thin pellicle of cellulose which we call the cell-wall had enclosed, to form the spore, two nuclei instead of one as is the rule. Certainly the conditions of fruiting were, after all, not quite normal. Fruiting ensued before cell-division had had time in each case to become complete; hence the giant or double spores. Some of these spores, a few days later, were sown in water, placed in an incubating oven, where, in a few hours, they germinated by the simple breaking of the cell-wall, each giving rise to a tiny amœboid speck of protoplasm, motile, free. These, could they have found nutrition, would no doubt soon have greatly multiplied by simple cell-division, and gone on at length to form a new plasmodium like that with which we started.

Such was our experience in the laboratory, correspondent, no doubt, in all essential particulars to that which occurs out of doors in all appropriate seasons of the year, and such is the life-history of the slime mould generally.

But after all these were laboratory experiments, like nature, correspondent indeed, but still meagre and poor by comparison, as physiological laboratory experiments are pretty sure to be. To study slime moulds and know them we must go out of doors and be content to stay out of doors, for a day at a time sometimes. The laboratory may help us, to be sure, but the lack of it need not greatly hinder us. In moist and mossy woods, by perennial springs and streams these things are at their best. The Atlantic seaboard affords, therefore, the richest variety for this continent, the woods of Maine, and all New England, New Jersey, Pennsylvania, nor less the region farther south. Students in these localities have, accordingly, some advantages; they have profusion and variety.

In the latitude of New England the best time to begin these studies is perchance in June. The climate of Iowa, precipitation now aside, is perhaps not very different from that of Massachusetts. With us about the time the Mertensia shakes out its blossoms and the Polemonium is in fullest flower, on some fair day that breathes the earliest airs of summer, the student wandering in the woodland is sure to see, perhaps

flat on the surface of a log or stump, perhaps half-way up the bole of some oak tree, perhaps spread in golden profusion over some bed of leaves or even living moss, the forming fructification of *Fuligo*, a mass of yellow not unlike the broken yolk of an egg, sometimes tinged about the margin by shades of red and brown, but conspicuous, commanding attention alike by its color and its substance, now as two hundred years ago, when Marchand first described it about the tan-yards of Paris. This is at once the largest of the slime moulds and, with us, the earliest to form its fruit. In 1882, Sachs, in his celebrated lectures on the Physiology of Plants, tells of this species in language which will doubtless seem a wonder-story even yet to many readers; yet all that Sachs says of this species is strictly true. Schweinitz, who both in this country and in Europe, a hundred years ago, collected and named not a few slime moulds, but who really little understood their nature, tells of a specimen found by a blacksmith's forge (in South Carolina), in the morning, calmly fruiting on iron that had been red hot the night before! A century or two earlier, this had certainly been a portent or a prodigy. If our student is fortunate enough to find his specimen in its mucilaginous condition, having just concluded its migrations, he may leave it to be revisited, *Jove favente*, on the following day, when instead of slime he may expect to find a more or less hardened crust like stiffened foam, overlying a mass of sooty spores, dry and fine. This is the final fruit. A few days later the wind will have borne the spores away and only a thin whitish film may remain behind to mark the place of the singular transformation.

Fuligo is perhaps the first slime mould to be recognized by the beginner. If a student of fungi, especially if a collector of puff-balls, he has probably already made the acquaintance of the common *Lycogala epidendrum* (Buxb.) L. The plasmodium of this species is red, not a very deep red, but bright enough to attract attention; to the older writers suggestive of vermilion. This appears usually a little later in the year, say in July, August, and so through the fall.

Following closely on the maturing of *Fuligo*, or even contemporary with it, are to be found the plasmodia of many other species, less frequently observed because in general less conspicuous. They may be sought by rotting logs, around settled heaps of wind-driven leaves, in neglected corners of the garden. Here we may meet the pale venulose creeping threads of some of the *Didymia*, the richer yellows of the *Badhamia* species, the creamy nets of some of the Didermas,

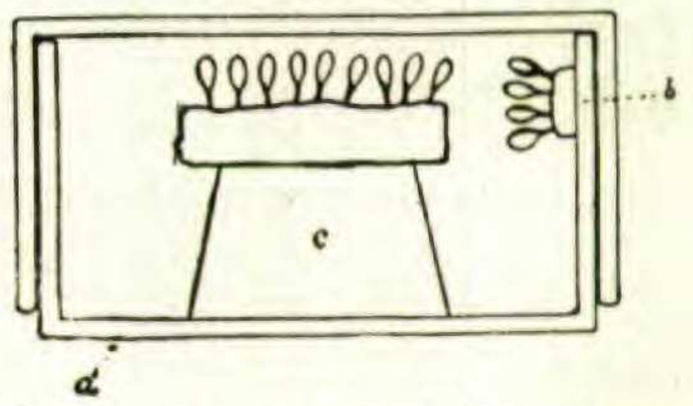
the snowy reticulations of *Diachea*. It must be understood in all cases that the color of the plasmodium in the same species varies with the progress of development, the food-supply and perhaps for other reasons to us unknown. The tints are not inherent, but are due to the presence of particles suspended in the protoplasmic stream. A plasmodium accordingly often loses its characteristic color as it passes into fruit.

Later in the season the plasmodia of the autumnal species begin to put in an appearance. The jelly-like whitish or greenish masses which later form our species of *Stemonitis* may be seen as early as July or August, but are most common in September. Probably not a linden tree falls to decay in our northern forests which does not bear at least one abundant crop of *Stemonitis*, certainly *S. maxima* Schw., and probably other species. The coniferous logs of Washington and Oregon, and doubtless of all our northern woods, bear quantities of *Stemonitis* in various species. *Comatricha* and *Dictydium* are common on logs of oak, while *Diderma floriforme* Bull. spreads its white or watery plasmodium inside oak stumps and forms its fruit in darkness, even sometimes in the ground. In the latter part of August and in September, the creamy plasmodium of *Mucilago* is everywhere in evidence, streaming amid piles of rotten leaves, climbing the living stems of herbaceous plants, there to hang in curious foamy masses of clustered fruit, an inch or two in length, unmistakable. The whole Trichiaceous series may now be sought, some with watery plasmodium rounding up in sporangia, white as ivory (*T. varia* Pers.), then dull yellow, ochraceous, orange; some with plasmodium scarlet, *T. decipiens* Pers., or rosy purple as *Arcyria denudata* L., or coral-red as *Hemitrichia vesparium* Batsch. In autumn too some of the most common Physarums are abroad with their plasmodia, on leaves, in wood-heaps everywhere, their fructifications on straw, on sticks, on every humble thing. Some species late in the year whiten, as if by frost, the earthward side of every fallen log, especially of aspen, linden, willow. Another autumnal form sure to be discovered is again one of the giant species, *Enteridium splendens* Morg. In some rocky damp ravine, on some barkless log, half rotten, we may discover a row of whitish or flesh-colored small cushion-like masses, perhaps a half a dozen of them. Another day we seek the place again; the cushions have changed to umber heaps covered with shining film, within like tiny sponges packed with spores.

To describe in detail the beauties of structure which the microscope reveals in the sporangia of these wonderful plants is beyond the scope of this paper. Some notion, however, of their variety and delicacy of form is given by the accompanying plate, which represents species of six of the forty and more generally known in the United States. All the species figured are found in New England, and one (*Comatricha cæspitosa* Sturgis) was first discovered there.

But it is proper now to offer a hint or two relative to the preservation and subsequent care of the materials we have gathered in wood and field. It is idle to collect the objects of natural history unless we may study them, and for satisfactory study they must be properly preserved. The care of the dainty forms we here discuss begins in the field. We should so carefully remove our material from its place of growth as not in the least to mar its pristine beauty. The collector should go armed with a stout knife, to cut away, if need be, a block of wood; he must carry a sufficient number of small boxes in which his finds may be stowed for safe transportation. Specimens, no doubt once good, often come in ruined by careless handling. If the specimen is to be of value it must be subject to no ill usage whatsoever.

Once we have our material at home it may be laid out on tables to dry, preparatory to mounting for the herbarium. Herbarium specimens are best cared for by mounting in small boxes, which may be selected of such size that a certain number will exactly fill a shallow covered tray, say one inch deep, and of the dimensions, outside, of standard herbarium-sheets. In these little boxes specimens may be so mounted as to be examined by the microscope with ease. A good method is shown by the accompanying figure. Here to the bottom of the box (*a*) is glued a bit of cork (*c*); on this is fastened by a drop of glue a bit of the material carrying the slime mould. This mount should be just so high in the box that the sporangia will escape the lid when the box is closed. A smaller bit of material may be similarly attached to the box side (*b*) for examination by the microscope in this position. Nearly all the small-fruited forms repay study, simply as dark objects, under the low powers of the microscope. No tiny natural objects evince a more elegant symmetry of form, more delicate shadings of color than do these.



For more exact study we must prepare our materials for investiga-

tion under lenses of highest magnifying power. To this end various methods of manipulation have been suggested. For some species it is desirable to mount the sporangium on the slide dry, in natural condition. This is essential in studying the *Stemonitis* species and the Cribrarias. Blown-out specimens are to be selected. In ordinary cases, however, we must resort to other methods, methods which will bring to all parts their natural fullness and will also render them less opaque. For these purposes, for temporary mounting, a weak solution of potassic hydrate will be found serviceable, to be followed by glycerine, if the specimen is to be kept any length of time.

But of the various matters of microscopic technique it is perhaps less needful here to speak. It is rather sought here to win for a hitherto little-noticed, but certainly remarkable group of living things a wider place in the attention and regard of students. Of course, for the proper appreciation of these things we must be children of nature, lovers of the natural world and sympathetic with all that goes on there. The consolations, the delights of nature are not for those who label things, who spend time in a vain attempt to harmonize the rules of nomenclature; her rewards are for those who love to watch the consistent harmony of her deathless cycles, and who in the secrets of her humblest forms can read the stately march of her sublime ongoings.

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Explanation of Plate 16. — Fig. 1, *Tilmadoche viridis* (Bull.) Sacc., a single sporangium magnified x 25; 1*a*, the same reversed; 1*b*, the same after spore-dispersal; 1*c*, Capillitium from a similar sporangium x 750. Fig. 2, *Craterium minutum* (Leers) Fr., sporangia with unusually long stalks, magnified. Fig. 3. *Comatricha cæspitosa* Sturgis, a cluster of sporangia x 4; 3*a*, the capillitium highly magnified; 3*b*, a single spore x 1600. Fig. 4, *Enteridium splendens* Morgan, æthalium (compound mass, imperfectly divided within into sporangia) natural size; 4 *a*, a spore x 1400; 4*b*, capillitium x 420. Fig. 5, *Cribraria aurantiaca* Schrad., sporangium containing spores x 30. Fig. 6, *Arcyria denudata* (Linn.) Sheld. Sporangia, two expanded, one still closed x 20; 6*a*, a part of the capillitium x 750.

A BLUE-FRUITED HUCKLEBERRY.

B. L. Robinson.

While collecting some plants on the eastern shores of Thorndike Pond at Jaffrey, N. H., in the late summer of 1896, I noticed two varieties of fruit on the huckleberry bushes (*Gaylussacia resinosa*). The berries on some bushes were, according to the laws laid down for